ISSN 2078-6115. Вісник Львівського університету. Серія економічна. 2023. Випуск 64.
Visnyk of the Lviv University. Series Economics. 2023. Issue 64.

ЕКОНОМІКА ЯК НАУКА. ТЕОРІЯ, ПОЛІТИКА І ПРАКТИКА

DOI:

УДК 65:502/504(075.8)
JEL E 60

A PHYSICAL AND ECONOMIC FRAMEWORK FOR THE CREATION OF A PREVENTIVE MANAGEMENT SYSTEM OF CLIMATIC CHANGES

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Abstract. *The ongoing climate change causes destructive phenomena in nature, the economy, and society. Therefore, the conservation of the planet's climate system by improving a system of management in this sphere is one of the major problems. We suggest that the system approach to climatic management should be based on the transdisciplinary methodology for research of complex natural and socio-economic processes occurring in the terrestrial biospheric space.*

Taking the physical and biogeochemical parameters of this space into account gives the possibility to form a new system of evaluation and management in economic science and practice. Application of this system has benefits because makes precautionary managerial decisions for climatic sustainability. Implementation of scientific concepts and laws justified by V. Vernadsky, as well as of modern natural and social scientific achievements, into management systems, gains particular importance in this context.

We offer a new physical-economic approach to the creation of a system of preventive management of climatic change.

Keywords: *physical and economic methodology; pellicle of life; preventive management of climatic changes; physics of space of Earth's biosphere; spatial capital of pellicle of life; terrestrial ecosystems, Baltic Sea Region.*

Introduction. Today, the economy is increasingly suffering from the turbulence caused by natural and, in particular, climate change that has engulfed our planet. Violation of the stability of the climate system has reached a critical level, accompanied by rising temperatures and shifting climatic zones of the world, and, consequently, the growth of natural disasters and negative changes, which are becoming more aggressive. According to the Intergovernmental Panel on Climate Change, global temperatures will rise to 1.5^{0}C by 2040 under current conditions. The consequences of such climate change are projected to increase food shortages, fires, and water shortages, and the total economic loss worldwide will be from 544 trillion USD USA [43]. How to prevent these dramatic events from unfolding? What needs to change in the economic life of the planet to stop the greenhouse effect and keep the temperature rising at 1.5^0 C?

The UN International Climate Summit (COP26), held in Glasgow (Scotland) in early November 2021, was dedicated to these pressing issues and outlined new challenges facing the world in preventing further climate change. A climate pact was adopted, the key points of which were:

- gradual reduction of the use of coal and other hydrocarbons as environmentally hazardous fuels, which causes the growth of the carbon footprint in the economy;
- analysis of the situation on a more regular basis;
- increase financial assistance to poor countries to combat climate change.

It is obvious that the analysis of the situation with climatic changes requires the determination of new estimates.

Valuation and analysis of the state of nature of Earth's biosphere is a topic of large political and scientific interest, expressed by the approaches of *Millennium Ecosystem Assessments* [MEA, 2005] and *The Economics of Ecosystem Services and Biodiversity* [LEEB 2010].

At the same time the difficulty of communicating nature values to policy makers – unless nature values carry a price-tag – has led many economists and ecologists to advocate monetary valuation of nature for pragmatic reasons, reflecting that "economists and policymakers speak the same language" (ten Brink, 2006).

Some criticism is raised of anthropocentrism as focus on monetary valuation of nature [Spash, 2008].

Continued exploration of different ways of building bridges between ecological and economic approaches is therefore important in the context of the formation a new policy to prevent climate change.

In this article, we consider how the preventive approach as a policy of climate changes tool can be enhanced by taking into account a physical and economic framework for ecosystem sustainability measurement.

It is obvious that the cardinal global measures and efforts of all countries of the world to reduce greenhouse gas emissions and decarbonize their economies will not be possible in a short period of time. However, it should be realized that the solution to these problems lies in the following two areas: – achieving carbon neutrality on the one hand and a comprehensive increase in biomass (phytomass) of green vegetation on the planet – on the other. Because its adsorbing capacity will be able to neutralize greenhouse gases entering the natural environment. On the other hand, it is a fund of the photosynthesizing capacity of the biogeocenotic cover of the Earth's surface, which ensures the stability of local climatic conditions. And for this, we need to find out the conditions for maintaining and increasing the adsorption capacity of the

ISSN 2078-6115. Вісник Львівського університету. Серія економічна. 2023. Випуск 64

phytomass of the Earth's biosphere. It is important to find out the conditions of its reproduction within the pellicle of life as the main organizational, energy, and biogeochemical block of the biosphere [15]. This terrestrial shell of the existence of living matter is clearly structured and is characterized by a certain cycle of energy, matter, and bioinformation (according to V. Vernadsky) [39]. The pellicle of life plays a key role in neutralizing the carbon footprint, and thus can significantly slow down the growth of the greenhouse effect, ie the «common blanket» that covers our planet and poses new environmental and economic risks. The pellicle of life is the biogeocenotic cover of the Earth's surface. The pellicle of microorganisms, fungi, plants, animals, and humans is concentrated in this cover. Its thickness ranges from a few decimeters in cold deserts to hundreds of meters in forest and marine ecosystems. Within its boundaries «living matter» is in a scattered state [38].

The pellicle of life is a layer of living matter; a set of terrestrial and surface water biogeocenoses that contain almost the entire mass of living matter of the biosphere. Exactly here new phytomass is produced and the photosynthesis reaction takes place. In view of its great importance in the processes of greenhouse gas absorption and reduction of the carbon footprint by the economy, there is a need for its monetary evaluation. To do this, it is necessary to expand the coordinate system of economic research in general and macroeconomic analysis in particular. Based on the paradigm of embedding the economy in the space of the pellicle of life, its green phytomass can be interpreted as an autonomous natural investment in the economy, without which success in the system of its decarbonization can not be achieved. The growing demand for these investments necessitates the need to consider the modern economy in the three-dimensional space of the pellicle of life, covering the level of terrestrial ecosystems (TES), as well as the level of society and its management. Thus, it can be argued that due to climate change that has engulfed our planet, the objective limits of knowledge of macroeconomic processes and phenomena have changed significantly. The object of research and modeling should become the ecological and socio-economic space the pellicle of life and its interdisciplinary issues (ESES).

Literature Review. At the same time, in the scientific research of various environmental and ecological economists, these issues are considered mostly in isolated scientific disciplines. Thus, the discourse on the spatial stability of the Earth's surface (Kissinger and Reese, 2011) focuses on accounting for natural resource flows using ecological footprints (Weinzettel et al., 2014) or on human appropriation of the pure structure of primary production in wildlife (Erb et al., 2009). Political environmentalists focus on the social consequences of land tenure changes (Rully et al., 2013). International institutions (UNEP, etc.) are interested in assessing the world's ecosystems. However, most approaches to such estimates are based on either anthropocentrism or ignore the exchange flows that exist in the living nature of the Earth's biosphere (Pascual et al., 2014; 2017; Schreter 2016). It should be noted that since the adoption of the Millennium Ecosystem Assessment (2005), scientific schools around the world have recognized a significant difference between social systems and natural ecosystems in the context of applying values to the usefulness of their assets. Some researchers have substantiated the different scales of the study of ecosystem services and their classification (R. Costanza). At the same time, the above approaches adhere to anthropocentric worldview philosophy and ignore interdisciplinary research and teachings on the biosphere and pellicle of life of V. Vernadsky.

There are also interesting approaches to building qualitatively new models of the economy of climate change prevention. Particularly valuable, in our opinion, is the paradigm of the stationary economy proposed by the world-famous American scientist H. Daly. As H. Daly rightly believes, "Adopting a stationary economy at the macro level (although, of course, allowing for better distribution at the micro level) helps us avoid shocks beyond the environmental limit.

Prof. H. Daly believes that the overwhelming obsession with economic growth puts us on the path to ecological collapse, sacrificing the very support of our well-being and survival. To change this sinister trajectory, we must move towards a stable economy focused on quality development, as opposed to quantitative growth and the interdependence of the human economy and the global ecosphere.

We support and join this idea with some additions – the modern physical and economic methodology [18].

The complexity of studies of conditions of biogeochemical productivity and reproduction of the space of the pellicle of life requires interdisciplinary research, namely the theories and laws of such sciences: nonlinear and nonequilibrium thermodynamics, geochemistry of landscapes, biophysics, geobotany, ecology– physical-economic doctrine by S. Podolynsky, doctrine by V. Vernadskyi about biosphere and pellicle of life, spatial economics, and macroeconomics. A combination of these studies allowed us to approach the justification of this new methodology.

Thus, the physical-economic methodology is a methodology for understanding the physics of space of the pellicle of life, within which the economic activity of humans is carried out in order to determine the optimal limit (volume) for it, to develop non-market mechanisms for preservation of biodiversity of living matter and to justify qualitatively new laws of value and the money circulation. The use of this methodology is especially relevant in connection with the need for a nature-centric approach to assessing the value of supporting functions of different TES and «pellicle of life» in general [20].

By developing this methodology now, it is possible to create a system of effective, preventive in its content, climate change environmental management, which avoids new ecological changes in terrestrial ecological systems and preserves their natural productivity, thus, ensuring sustainable functioning of the pellicle of life. This, in our opinion, can be achieved only by integrating the latest advances in the development of various natural sciences into the economics of climate change related to environmental and economic relations. Implementation of objective biophysical and geochemical criteria for the preservation of biomass (phytomass) of living matter in the system of cost parameters of the real and monetary economy.

The purpose of the article – there is a generalization of knowledge from various fields of natural and social sciences, especially physics and economics, to substantiate interdisciplinary principles and methods of evaluation of the sustainability of the pellicle of life in the context of the formation of management for the prevention of climatic changes.

ISSN 2078-6115. Вісник Львівського університету. Серія економічна. 2023. Випуск 64

Setting the objectives. In order for the green vegetation of the pellicle of life to be an effective adsorbent of greenhouse gases, it is necessary to provide conditions for her reproduction. According to the doctrine of V. Vernadsky, the possibilities of reproducing the pellicle of life are spatially determined [38]. That is, at each point of her space, there is a significantly different potential for its biogeochemical productivity and, consequently, reproduction. Her volume is also different. It can be argued that due to climate change that has engulfed our planet, the objective limits of knowledge of macroeconomic processes and phenomena have changed significantly.

Thus, in forests, the thickness of the pellicle of life reaches several tens of meters; in fields and steppes – several meters. This suggests that economic policy for the conservation and increase of biomass (phytomass) of the pellicle of life should be based on a differentiated (spatial) approach and based on the laws discovered by V. Vernadsky on spatial heterogeneity of the biosphere and conservation of its biomass [38; 39].

At the same time, the actual volume of annual phytomass production as a terrestrial product of photosynthesis is a criterion for the supportive function of each TES. Consideration of this criterion will give us the opportunity to get rid of anthropocentrism in their assessment.

Now the pellicle of life suffers from deforestation, soil erosion, and desertification, which is a consequence of economic activity. This has led to significant changes in the biosphere as a whole. Additional release of carbon dioxide into the atmosphere due to increased economic activity and decomposition of plant mass and humus has led to increased greenhouse effect and the formation of various geochemical anomalies that lead to modification and destruction of natural geochemical cycles and are very harmful to biota.

At the same time, as a result of deforestation, about 13 million hectares of the world's forests (an area equal to the territory of Greece) disappear every year. Today, the carbon footprint of the world's 20 largest companies is 350 million tons per year.

The constant decline in the volume of terrestrial production of photosynthesis is the result of too strong economic pressure on the terrestrial space of the biosphere. It is known that today the extraction of minerals is 25–30 tons per capita, 7% of which is used as raw material for various industries, the rest – pollutes the atmosphere, forming waste heaps, wastewater, damaging the environment. The area of forests and the amount of freshwater is catastrophically decreasing, biodiversity is narrowing, ocean waters are polluted, soils are depleted, and the ozone layer is disturbed [3].

Thus, a photosynthesis reaction takes place in the space of the pellicle of life, and a new phytomass of green plants is produced every year, covering 99% of living matter and thanks to which solar energy accumulates and oxygen is created, without which life on the planet is impossible.

In this context, we consider that introduction into scientific circulation and the problem of determination of a new category – «spatial capital of pellicle of life» becomes especially [17]. This capital is treated as a fund for photosynthesizing the working capacity of the biogeocenotic cover of each terrestrial ecosystem as a component of the pellicle of life. It has an energy-material nature. This is caused by the fact that the volume and efficiency of this capital determine the preservation of biodiversity and prevents climatic changes at the local level [19].

Methodology and Research Methods. According to the laws of nonequilibrium thermodynamics, the functionality of this capital is determined by the amount of free energy.

Free energy can be said to be a fraction of the internal energy of the capital that can be spent by the system to perform the work and be replenished in the process of contact with the environment [19]:

$$F = E + N \tag{1}$$

where F – free energy of the spatial capital of pellicle of life; N – negentropy budget of this capital.

Delivery of energy of the Sun to the Earth along with negentropy is simultaneously both a discrete and uninterrupted process characterized by flows and waves. The Sun's force field interacts with the energy of the TES force fields. The presence here of natural and economic environment indicates a particular structuring of the latter. Electromagnetic, gravitational, and biological fields interact with each other and with the socio-economic environment of the TES, which has its own fields. The lack of resonance of these fields because of the inconsistency of demands of the "market" of nature of a particular territory and the scale of economic activity leads to the dissipation of a certain amount of energy and, consequently, to the reduction of the negentropy budget [15;19].

Thus, the negentropy «budget» of spatial capital is a determinative component of the Earth's energy budget (according to S. Podolynsky), and this is why its volume is the indicator that sets one or another «scenario» for the economic activity of humans. If this budget is reduced, then the anthropo-technogenic load on the core of each TES, terrestrial ecosystems, must decline accordingly. That is, the spatial natural resource intensity of the economy must decline symmetrically. This conclusion is the key element for understanding the pith and marrow of sustainability of spatial capital of pellicle of life.

On the other hand, the sustainability of the negentropy «budget» of spatial capital lies at the heart of V. Vernadsky's law of the Earth's biomass conservation and, therefore, shows their interdependence [38].

Thus, the primary productivity of green vegetation of biogeocenotic cover of each TES as a component of the pellicle of life is the basis of organic matter not only in the biological cycle but also in the greenhouse gas cycle, which contributes to the decarbonization of the economy. The total air purification capacity of full-fledged stands, which formed 4 tons of leaves per 1 hectare of area during the growing season, is about 10 tons of CO_2 [3].

This work of the living nature of the pellicle of life, which ensures its stability, is embodied in the total annual production of living matter of landscapes, which is estimated today at 750 trillion USD [37]. Of course, this calculation cannot be taken as the full value of all terrestrial ecosystems. At the same time, the biosphere, in contrast to factories and firms, «produces» its products for 3.9 billion years without a break for «repair». If we continue the analogies, the current value of the Earth's ecosystems can be estimated by comparing it with the products of the biosphere over this long period [12].

Thus, the annual production of green vegetation on the planet is about 2402.71 billion tons. The largest production of this vegetation, apparently, is in tropical forests (102t/ha). It

ISSN 2078-6115. Вісник Львівського університету. Серія економічна. 2023. Випуск 64

is worth mentioning here that the annual output of the chemical, metallurgical and mining industries in the world economy is a little more than 10 billion tons [41; 42]. This comparison once again emphasizes the importance of living matter products for maintaining the stability of terrestrial ecological systems and indicates the level of power of living matter in the reproductive processes of the Earth's biosphere and the neutralization of greenhouse gases. This requires appropriate biogeochemical analysis of the productivity of ecosystems in different landscapes.

Each TES, as a local natural market, is characterized by a certain biological cycle, which has a different capacity depending on the amount of phytomass. The larger it is, the higher the capacity of biological circulation in it.

Results. In general, the volume of annual growth of spatial capital of pellicle of life production, carried out, in particular, on the Earth's surface, is evidence of whether or not preserved natural (biogeochemical) productivity of TES. Each state, carrying out economic activities, participates in the emission of greenhouse gases of a certain amount. At the same time, its ecosystems are characterized by a certain biopower, producing annual products of living matter that should neutralize these greenhouse gases. How can the problem of neutralizing the carbon footprint be solved organizationally? In our opinion, this can be solved in this way.

If the biopower of existing ecosystems in the country is much less than the required potential to neutralize these gases, it will be forced to «buy» appropriate biophysical infrastructure in other countries or take carbon credits from them. Thus, there is a need to establish a market for carbon credits, the demand for which is likely to grow. Landowners will be able to receive significant income from the creation of biophysical infrastructure. Countries with low biopower capacity of their ecosystems and those entities that produce a significant carbon footprint will take carbon credits from forest owners in other countries to offset CO_2 emissions from new trees and forests. This is, of course, the global scenario of neutralizing greenhouse gases in the world. However, in order to prevent further destruction of the ecosystems of the pellicle of life – a very important task is also - to reduce the anthropogenic pressure on them, in proportion to the state of preservation of the potential for sustainability of their biogeochemical productivity. Because, this pressure can be a destructive factor and reduce of their biopower.

Let's consider these questions in more detail. As you know, there are two critical indicators that characterize the spatial capital of the pellicle of life: the total biomass (phytomass) of living matter, which is denoted by (B), and annual production, which will be denoted as – P.

It is these indicators that make it possible to distinguish between such types of landscapes as steppe, desert, tundra, and so on. Depending on how they are biological cycle, distinguish their regulatory (natural) level of biological capacity. In this context, the indicator characterizing the ratio of the annual production of living matter and biomass in different types of landscapes – Ik_e – deserves special attention.

This indicator (coefficient) Ik_e, which is determined by formula 1.2 in fact, characterizes the level of development of the «economy» of the nature of the pellicle of life [19]:

$$Ik_e = \frac{\lg P}{\lg B} \quad (2)$$

where: P – the volume of the annual production of living matter; B – biomass (phytomass) of living matter.

If we consider the coefficient Ik_e in the historical aspect, it should be noted that with the evolution of vegetation of landscapes, there is a tendency to increase it [30; 20]. Thus, it can be argued that Ik_e reflects the degree of progressive development of the landscape or, in the language of economics, «return on investment» in the natural landscape. Therefore, in our opinion, the need for monitoring the level of this natural «return on investment» (Ik_e) is obvious. If economic activities on nature management are carried out within one or another landscape, then it is obvious that it is necessary to harmonize its volume with the natural productivity of this landscape. Geochemical studies have shown that by establishing the course of progressive development of natural landscapes in the development of geochemical history (in relation to Ik_e), it is possible to extrapolate this dependence to ecologically unfavorable (disturbed) landscapes [18].

Table 1 presents the leading indicators of the natural productivity of different types of biogenic landscapes.

Table 1

The main ratios of biomass and annual production of living matter in different landscape systems [30]

Type of landscape system	Landscape system subsystem	Biomass (B), c/ha	Annual production (P), c/ha	"Return on spatial capital" in the landscape system ($Ik_e = \frac{\lg P}{\lg B}$)
Wet deciduous forests	Landscapes of beech forests	3700	130	0.59
Wet deciduous forests	Landscapes of birch forests	2200	120	0.62
Luke	Grass meadows	110	765	0.95
Steppes	Saline steppes	16	6.1	0.66
	Semi-shrub steppes	43	12.2	0.65

Table 1 shows the normative indicators of the volume of phytobiomass, annual production of living matter, and the indicator Ik_e for some landscape systems, which shows the volume of production of the annual production of living matter per unit of biomass. To some extent, here, in our opinion, we can draw an analogy with any subject of production in the economy because the higher the level of Ik_e, the more efficient the «economy» of the landscape ecosystem and hence its greater «return on spatial capital of pellicle of life».

Cultural landscapes of the pellicle of life, in particular fields of herbaceous plants, allow people who carry out economic activities on them to receive a much larger amount of biomass than in natural herbaceous landscapes. It should be noted that modern agricultural techniques, selection, and application of fertilizers provide (collection) on cultural landscapes

2–3 crops per year. In this case, the annual production of living matter significantly exceeds the biomass, P>B and $Ik_e>1$.

Significant changes are taking place in terrestrial ecosystems under the influence of climate change. This is primarily a change in vegetation and pedosphere. Because the anabolic block in them is represented by the phytocenosis and the catabolic – by the soil, they will react differently to global climate change. However, regardless of which of these metabolic blocks has a higher resistance to temperature changes, the stability of the biogeocenosis in the TES will decrease, as there will be processes of reducing their negentropic budget by increasing entropy (look formula 1). It is the combination of knowledge of nonequilibrium thermodynamics and the doctrine of the biosphere of V. Vernadsky, which is based on the laws of geochemistry and biophysics of landscapes, that leads us to this conclusion [39].

In order to preserve the resources of the pellicle of life and its reproductive potential, the problems of introduction of effective local monitoring of actual "production" capacity and "work" of the Earth's biogeocenotic cover become especially important. As we have already mentioned, the ecosystem of each landscape is characterized by a certain normative potential of biogeocenotic cover. This is a criterion of its photosynthetic activity. Unfortunately, today the loss of forest lands and forest cover of the Earth's surface causes a decrease in the energy and material potential of photosynthesis. This means that the particle not used in the process of photosynthesis of solar energy is not deposited as dry matter but is spent on physical heating of the Earth's surface, soil, water, and aboveground air. And this, in turn, causes dangerous geophysical changes in the pellicle of life due to increasing entropy. At the same time, it changes the local climate.

The model of ecologically sustainable economic activity in the space of the pellicle of life is based on the method of the function of an ecological proposal of the Earth substantiated by us [18; 19].

The basis of the approbation of the method of an ecological proposal of Earth is the local monitoring of the state of actual biogeochemical productivity of the spatial capital of pellicles of life. This becomes especially important in the context of climate change.

Such local monitoring was carried out by scientist S. Milevska [32]. The aim of the study was testing on the example of a model region, a method of estimation of the production potential of forest ecosystems and the consequences of anthropogenic changes there. The object of study is a typical Carpathian lower mountain forest in the basin of the river Lyuchka, an area of 14,806 ha. It has long undergone considerable agricultural transformations. Studies were based on cartographic modeling of modern anthropogenically transformed biogeocenotic cover using large-scale satellite images. The main types of biogeocenotical cover were defined according to the altitudinal zonation of vegetation of the parts of the mountain terrain and the prevailing types of soil and hydrological conditions. For analytical procedures a database of materials describing the biometric features of the forests was created. It is possible to perform calculations of average and potential biometrical parameters of stands growing in different climatic, soil and hydrological conditions. The structure and the biological diversity of different vegetation types was determined by construction of mapping models of spatial structures of the basic types of biogeocenotic cover. The biological productivity of the main types of forest ecosystems was determined on base of the volume of timber stands. The mass of dry wood was determined taking into account its size and standard density of wood of different tree species. Calculation of the total volume of forest biomass was performed using the conversion factors of weight relative to the trunk timber volume. The mass of carbon deposited accounted for 50% of the total biomass. The average annual growth of biomass and carbon deposited was determined by dividing the volume of the stands by their average age. Calculation of phytocenosis consumed as a result of the photosynthesis reaction of CO_2, H_2O, and light energy was performed, taking into account corresponding material and energy ratios.

In general, in the course of one year, the biogeocenotic cover of the model lowland area could deposit as a result of photosynthesis for the restoration of potential vegetation cover 43.3 ths tons of carbon while consuming 159 ths. t of CO_2, and 65.2 ths t of H_20, and $1{,}724*10^3$ GJ of light energy, which is equivalent to 479 GW-hour. During this process, O_2-115.7 ths. t would be emitted into the atmosphere. In terms of 1 hectare, this is equal to C-2.92 $t*ha^{-1}$, CO_2-10.7 $t*ha^{-1}$, H_20-4.4 $t*ha^{-1}$, 0_2-7.8 $t*ha^{-1}$, E- 116.4 $GJ*ha^{-1}$, which is equivalent to 32.3 $MW*h*ha^{-1}$. The total production capacity of photosynthesis of the modern biogeocenotic cover model area is 38% of the potential. As a result, the energy loss is 20 $MW*h^{-1}*ha^{-1}$ light energy to 1.9 $t*ha^{-1}$ less than the deposited carbon 6.7 $t*ha^{-1}$ less carbon dioxide used, 2.8 $t*ha^{-1}$ water is not used, 3.9 $t*ha^{-1}$ oxygen is not returned to the atmosphere. The large specific amount of unused resources of productivity of biogeocenotic cover, carbon dioxide, light energy, untranspired moisture in the air, and unemitted oxygen can cause a significant impact on local climatic conditions [32]. This method it possible to carry out physical and economic assessment of terrestrial ecosystems in pellicle of life.

This assessment takes into account the role of each ecosystem in reproducing the sustainability of the space of pellicle of life. It will obviously be differentiated since the natural return on spatial capital of the pellicle of life of each TES is different. This return of spatial capital shows the efficiency of the «economy of nature» of each TES. Therefore, in our opinion, it can be an objective criterion for assessing the value of each TES for the existence and reproduction of the pellicle of life in genera [19].

Currently, in the scientific literature, various assessments of ecosystem benefits, which are produced by different landscapes, are presented [4;9;10;24;25]. These assessments take into account their social value. For example, according to calculations Häyha T. the monetary equivalent of ecosystem social benefits produced by Alpine forest ecosystems per year is from 300 to 6100 €$*ha^{-1}$ $year^{-1}$, which on average is 820 €$*ha^{-1}$ $year^{-1}$ [24]. According to the data in Table 1, the average normative return on capital Ike_n in a forest ecosystem is 0,60. Suppose, that an actual return on capital Ike_a in our forest ecosystem will make – 0,53. This means that the actual biogeochemical capacity of our TES is lower than the normative one, and therefore the efficiency of the biological cycle is reduced in it. Taking into account the energetic and material regularities of existence and reproduction that we have given above, we propose a methodology of physical and economic assessment of the value of TES for the reproduction of the space of pellicle of life.

So, proposed by us methodology of physical and economic assessment of the value our forest ecosystem for pellicle of life looks like this:

ISSN 2078-6115. Вісник Львівського університету. Серія економічна. 2023. Випуск 64

$$E_{ph-e.\ sp.} = E_{soc.} \pm E_{soc.}(Ike_a - Ike_n) \quad (3)$$

$E_{ph-e.\ sp.}$ – specifical physical and economic assessment (one hectare) in TES;

$E_{soc.}$ – assessment of social value (one hectare) in TES;

Ike_a – actual natural return on spatial capital of TES;

Ike_n – normative natural return on spatial capital of TES.

$$E_{ph-e.\ full} = E_{ph-e.\ sp.} * S \quad (4)$$

where:

$E_{ph-e.\ full}$ – full physical and economic assessment of TES;

S – an area of TES.

Such monitoring and assessment of the biogeochemical productivity of different landscape ecosystems should become a defining element of preventive management in the field of climatic changes, as its results make it possible to prevent further anthropogenic transformations of the biogeocenotic cover of different landscapes. This monitoring is the basis for the application of our proposed method of the function of an ecological proposal of the Earth to assess the value of environmental services, goods, and supporting functions of terrestrial ecological systems. Such an assessment, in turn, can serve as an essential basis for the implementation of spatial planning of ecologically sustainable development of anthropogenically transformed landscapes. Because carrying out such planning, it is necessary to have information about the ecological condition of different landscapes, the criterion of which are indicators of the efficiency of their biogeocenotic cover, indicating the energy and material potential of photosynthesis of the earth's surface. Such a differentiated approach to the implementation of spatial planning in rural and other areas will provide an environmentally sound scale of management and optimal anthropogenic loads in accordance with the ecological capacity (capacity) of their living space [32].

Conclusions. Therefore, in order to form a new model of climate changes prevention management and economy, it is necessary to realize that approaching a more stable climate system is, first of all, ensuring the sustainability of existence and reproduction of the terrestrial space of the Earth's biosphere, i.e., pellicle of life. If in it a stable production of terrestrial products of photosynthesis, and each ecosystem of the landscape creates the appropriate amount of annual production of living matter, you can rest easy. However, to solve these problems, it is necessary to apply interdisciplinary new knowledge and models of the pellicle of life preservation functions. Obviously, neoclassical economics, which is dominated by mechanistic individualism, and focuses only on the subjective choice of the consumer, is abstracted from these problems. After all, the object of her research is closed, mechanistic economic systems, which do not seem to be related to the natural environment (NE) and energy and material resource flows that structure it. Consequently, this science, which considers all flow processes in the management system through the prism of Walras's theories of macroeconomic equilibrium, has no prospects for solving the problems of the interaction of natural, climate change, and economic change.

Today, the thesis is that to reduce the greenhouse effect, you need to radically change the model of production and consumption. The definition of production preconditions of economic activity is also an urgent problem, as there are contradictions between the neoclassical principle of marginal productivity of individual costs and physical principles governing production activities, in particular I and II laws of thermodynamics. Therefore, it is inappropriate to consider the theory of production from the standpoint of only models of production functions that do not take into account the patterns of functioning of the terrestrial space of the biosphere, i.e. pellicle of life in which this production activity is carried out. These issues cannot be solved by adding new variables (energy and matter) to existing production functions. Because there are laws that were discovered by V. Vernadsky – as the law of spatial heterogeneity of the biosphere and the law of constancy, which indicate the presence of spatial determinism in ensuring the sustainable functioning of the pellicle of life as a shell of the biosphere. Obviously, the construction (reconstruction) of a new economic science for environmentally sustainable development of the world requires a synthesis of biological, physical, geochemical, and environmental approaches, taking into account the laws of functioning of the pellicle of life.

Today, on the example of the greenhouse effect, we can see that about 50% of the carbon dioxide produced by the combustion of fossil fuels in the economy gets free of charge in natural absorbers. That is, a picture is created of the "joint implementation" of these emissions into the space of the pellicle of life outside their own living space (state).

In this regard, it is very difficult to determine the local consequences of increasing the greenhouse effect. Due to the international movement of capital and the export of dirty industries to poorer countries, the carbon dioxide produced as a result of these production capacities is emitted within their space, not the space of the countries that exported these industries.

The problem of property rights of the world's states to terrestrial ecological systems and their ability to absorb carbon dioxide is becoming relevant. That is, it is necessary to compensate for the local consequences of increasing the greenhouse effect. Today, the world is in a situation where all countries have experienced the threats posed by climate change. Therefore, we must finally recognize that only a clear spatial regulation of new scenarios of nature preservation, production and consumption will be able to give a clear assessment of the contribution of all countries in the process of absorbing carbon dioxide and methane. Thus, we approached to new spatial model of ensuring the stability of the pellicle of life, based on the concept of the spatial capital of the pellicle of life and the assessment of its biophysical and geochemical utility.

Nowadays method of Earth's ecological proposal can become a basis for implanting a model of preventive management in the field of climate change in the Baltic Sea Region (BSR) of Sweden. In this region, ecological management focus on addressing climate change mitigation and adaptation, often via efforts that seek to alter the energy sector or via efforts related to sustainable production. The goal of this management is that the region becomes a low-carbon economy.

The common environmental and sustainable spatial development issues for the region are caused, on the one hand, by common development trends of the Baltic Sea Region countries and country groups, as well as, on the other hand, by the above-mentioned aspects of ecological, social, and economic unity. The first group includes the common agro-environmental (sustainable food systems), climate change, innovation and education for SD, sustainable rural and urban development, sustainable Consumption and Production (CBSS, 2015), as well as the risks of intensified spatial development associated with industrial and recreational prospects (countries of EU) [16].

The second group of common sustainability issues includes flood prevention, toxic waste storage, river basin management in the Eastern part of the region, and, most importantly, biodiversity conservation in the face of intensified spatial development.

All this determines the need for systematic monitoring of the state of the biogeochemical working capacity of various terrestrial ecosystems of the region. This will be the first step towards implementing preventive management of climatic changes.

At the same time, Ukraine is currently at war with Russia, which attacked her. It is significantly increasing its carbon footprint not only on the European continent but also around the world. Therefore, the study of the dynamics of climate changes in connection with the Russian war in Ukraine should be the subject of an in-depth study. Military actions lead to negative consequences in the environment – the burning of land, destruction of forests and vegetation of terrestrial ecosystems, air and water pollution, man-made pressure on various ecosystems, and more. The direct hit of shells and missiles completely destroy the ecosystems of landscapes. Explosions and burning of parts of military equipment contaminate soils and water with heavy metals. The burning of machinery and infrastructure releases a lot of greenhouse gases.

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ФІЗИКО-ЕКОНОМІЧНА ОСНОВА СТВОРЕННЯ СИСТЕМИ ПРЕВЕНТИВНОГО УПРАВЛІННЯ КЛІМАТИЧНИМИ ЗМІНАМИ

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Зміни клімату, що тривають, обумовлюють руйнівні явища в природі, економіці та суспільстві. Тому збереження планетарної кліматичної системи через вдосконалення системи управління в цій сфері є ключовою проблемою. Ми пропонуємо системний підхід до кліматичного управління, що базується на трансдисциплінарній методології дослідження складних природних та соціально-економічних процесів в наземному просторі біосфери. Врахування фізичних та біогеохімічних параметрів цього простору дає можливість сформувати нові системи оцінювання та управління в економічній науці та практиці. Застосування цих систем має переваги, оскільки забезпечує запобіжні управлінські рішення щодо кліматичних змін. Реалізація наукових концепцій і законів, обґрунтованих В. Вернадським, а також новітніх природничих та соціальних наукових досягнень в цій системі управління, набуває особливого значення. Ми пропонуємо новий фізико-економічний підхід до створення системи превентивного управління кліматичними змінами.

Ключові слова: фізико-економічна методологія, плівка життя, превентивне управління кліматичними змінами, фізика простору наземної біосфери, просторовий капітал плівки життя, наземні екосистеми, Балтійський морський регіон.

Стаття надійшла до редакції 24.02.2023
Прийнята до друку 29.06.2023